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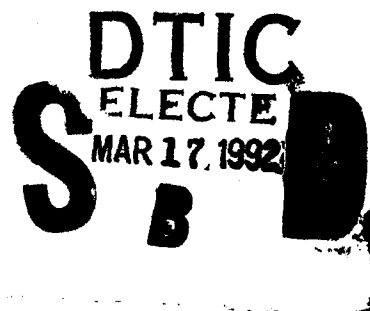


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# INFLIGHT MEDICAL/NURSING TASK PERFORMANCE

Regina Aune, Major, USAF, NC  
Garye D. Jensen, Major, USAF, NC  
Glen W. Mitchell, Lieutenant Colonel, USA, MC

December 1990



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USAF SCHOOL OF AEROSPACE MEDICINE  
Human Systems Division (AFSC)  
Brooks Air Force Base, TX 78235-5301



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GARYE D. JENSEN, Major, USAF, NC  
Project Scientist

  
F. WESLEY BAUMGARDNER, Ph.D.  
Supervisor

  
GEORGE E. SCHWENDER, Colonel, USAF, MC, CFS  
Commander

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# **INFLIGHT MEDICAL/NURSING TASK PERFORMANCE**

## **INTRODUCTION**

The purpose of this study was to evaluate and compare the ability of aeromedical evacuation crew members (AECMs) to perform certain specific inflight medical and nursing care tasks under conventional warfare conditions to their ability to perform these same tasks under chemical warfare conditions. These tasks are described in the Wartime Medical Work Center Description (WARMED-WCD) Functional Account Code (FAC) # 5640, Inflight Medical Care. The ability of AECMs to perform medical and nursing care procedures in conventional war scenarios has been well demonstrated in the past during actual aeromedical evacuation operations, although the NATO-standard vertical litter spacing of 45.72 cm (18 in.) is not always strictly followed. The ability of AECMs to perform these same medical and nursing care procedures under chemical threat conditions during aeromedical evacuation operations is not as well documented.

Low intensity conflicts could involve exposure to persistent chemical agents requiring rapid extraction of the wounded on tactical and strategic aeromedical aircraft. Recently, in Panama, Operation Just Cause demonstrated such rapid evacuation requirements. The potential need for the Medical Evacuation (Medevac) of incompletely decontaminated patients may be higher in such a low intensity conflict than in a European conflict with the Warsaw Pact.

The delivery of adequate nursing and medical care will be vital to wounded patients exposed to chemical agents. Our experience with Medevac procedures is based on conventional conditions involving both real and simulated casualties. Many AECMs automatically adjust patient loading patterns to patients' medical conditions, but little is documented about such procedures. The additional burden of chemical protective equipment (CPE) may further restrict vision and access to the patients as well as reduce AECM efficiency and endurance. Full patient loads, dictated by the need to limit contamination to few aircraft will make it necessary to closely comply with NATO-standard litter stacking procedures. These potential problem areas were addressed in this study.

## ASSUMPTIONS

The performance of aeromedical crews in conventional warfare is a matter of record; USAF aeromedical doctrine evolved from experience gained in conventional warfare, mostly since World War II. Military doctrine is the body of fundamental principles which guide the military forces in support of national objectives. Doctrine is directive, but its application requires judgment. In the USAF, the aeromedical mission involving AECMs has been broken down into WARMED/WCD tasks (doctrine) for conventional warfare. Consequently, the medical and nursing care task performance in a conventional setting has become the standard for comparison of task performance under a chemical threat. Since aeromedical evacuation operations in chemical environments would require both casualties and AECMs to wear CPE, it is assumed that some tasks will be more difficult to perform in CPE and that increased vertical litter separation may be required to properly perform inflight medical and nursing tasks. These assumptions were central to the study.

## METHODS

*In order to compare the ability of AECMs to perform medical and nursing care tasks under both conventional and chemical warfare conditions, simulated aeromedical evacuation missions were "flown" using the aircraft trainers located at the USAF School of Aerospace Medicine (USAFSAM).*

### Aircrew

Trained flight nurses and aeromedical evacuation technicians from the USAFSAM and the 34th Aeromedical Evacuation Flight (AEF) composed the basic aeromedical evacuation crews consisting of two flight nurses and three aeromedical evacuation technicians in accord with Military Airlift Command Regulation (MACR) 164-1, Worldwide Aeromedical Evacuation. However, one of the scheduled flight nurses became ill on the first morning of the study; an aeromedical evacuation technician, who was also a licensed vocational nurse (LVN), was substituted as the second flight nurse on the C141B simulator/trainer. The average physical characteristics of the AECMs assigned to each aircraft are presented in Table 1; Table 2 outlines the mean aeromedical evacuation experience levels.

**TABLE 1. AIRCREW PHYSICAL CHARACTERISTICS  
BY STUDY AIRCRAFT TYPE\***

Study Aircraft	Age (yrs)	Weight (kg)	Height (cm)	Arm Span (cm)	Inseam (cm)
C-130	31.2+5.1	80.4+7.7	175.6+8.2	173.0+9.	80.0+5.1
C-141B	31.0+8.7	80.0+8.7	179.8+8.8	174.4+13.1	80.8+8.7
Combined	31.1+6.2	80.2+8.3	177.7+8.3	173.7+10.17	81.1+6.6

\*All values are given as Mean + SD

**TABLE 2. AIRCREW AEROMEDICAL EVACUATION EXPERIENCE  
BY STUDY AIRCRAFT TYPE\***

Study Aircraft	C-130	C-141B	C-9	Mean Flight Total	Hours In Chemical Gear
C-130	195	51	607	854	3
C-141B	248	92	738	1,078	18
Combined	238	72	672	966	10

#### Randomization of Aircrew Members

Each flight nurse and each technician was randomly assigned to one of the two aircraft by the throw of a die. Each crewmember was given a number (from 1 to 4 for nurses and 1 to 6 for technicians). The number showing on the die was used to assign the first half of each group (disregarding repeats) to the C-130 and the second half to the C-141B. The assignments were checked for randomization, experience and anthropomorphic measurements using Student's t-test; no significant differences ( $p>0.05$ ) between the groups assigned to the two aircraft were found for any parameter. The crewmembers' mean anthropomorphic measurements were compared to the general population of similar age and sex. These comparisons also showed no significant differences ( $p>0.05$ ). Of the two females, the above procedures resulted in one being assigned to each of the study aircraft.

## **Facilities**

The C-130 and C-141B simulators located at Brooks Air Force Base, Texas, were used. These replicas are fixed structures which duplicate internal equipment in the aft sections of the respective aircraft; they can be rigged to standard aeromedical configurations. To lend realism, the sounds of appropriate aircraft noise in various phases of flight are played at high intensity through speakers mounted inside the mockups. Internal lighting is identical to that in the actual aircraft.

## **Clothing**

The standard flight uniform included a Nomex flight suit, cotton underwear, Nomex gloves, and leather flight boots. The CPE consisted of a two-piece set of mission oriented protective posture (MOPP) clothing with overboots, butyl overgloves, hood and helmet with chemical mask.

## **Scenario**

The participants were briefed as follows:

"A coup attempt has been made against the president of a friendly nation where a large American base is located. In the attempt, American military personnel were attacked. All US military installations in the area have been placed on full alert. A number of our troops have been injured and require air transport to secure medical installations for additional care. Due to the evolving situation, only immediate stabilizing care has been given thus far. This is the first aeromedical evacuation mission to fly into the conflict area."

For the second simulation involving chemically contaminated patients, the brief was modified to include:

"Small scale use of persistent chemical agents has been reported. The casualties have not been completely decontaminated due to destruction of our chemical decontamination capabilities by the insurgents."

## Evaluators

The evaluators were selected from flight nurses and technicians who had at least 500 flight hours of actual operational aeromedical evacuation experience. Prior to the start of the study each of the AECMs was tested individually by both evaluators for each of the tasks. All tasks had to be accomplished within current aeromedical nursing standards prior to further participation in the study. Each crewmember was able to perform all of the tasks. The inter-rater reliability during the testing phase was 100%. During the actual study protocol, the evaluators directly observed the performance of all selected tasks by the aircrews and assigned ratings to their performance. These ratings were: 1) AECM fully able to perform all components of the task (FA); 2) AECM partially able to perform some components of the task (PA); 3) AECM unable to perform any component of the task (UA). The evaluators were split between aircraft and remained in that aircraft through both phases of testing.

## Task Selection

Medical tasks were selected from the WARMED-WCD Functional Account Codes (FACs) #5640 for inflight medical care. One specific task was derived from each FAC task area. We determined those tasks most relevant to inflight care of minimally stabilized patients from forward areas. The tasks performed and tested in this study are listed in Table 3.

**TABLE 3.      SELECTED MEDICAL/NURSING TASK LIST BY STUDY NUMBER  
AND WARMED TASK NUMBER REFERENCE**

No.	WARMED	Task Number	Task Name
1.		02.01	Obtains blood pressure and respirations
2.		02.02	Performs tracheal suction (simulated endotracheal tube)
3.		02.03	Reinforces dressings and bandages (leg on distal side of patient)
4.		02.03.01	Reinforces dressings and bandages (abdominal and back injury)
5.		02.03.02	Administers medications (oral and intramuscular)
6.		02.03.03	Maintains fluids via oral route
7.		02.03.04	Maintains supplemental oxygen
8.		02.03.05	Inserts and maintains oropharyngeal airway
9.		02.03.06	Performs cardiopulmonary resuscitation
10.		02.03.07	Positions patient for comfort
11.		02.03.07	Offers comfort items, backrests and back rubs
12.		02.03.08	Manages orthopedic devices (cast and traction splint)
13.		02.03.08	Properly positions extremities
14.		02.03.09	Provides inflight meals and snacks

#### **Patient Simulation**

Twenty U.S. Air Force (USAF) and U.S. Marine Corps (USMC) enlisted service members from the USAF Military Police training course at Lackland Air Force Base, Texas, were moulaged as recently minimally stabilized patients. We selected 10 conditions from the standard training list (Table 4) of nursing care patients used at USAFSAM. Each aircraft carried ten identical patient simulations. In the chemical defense trial, patients were dressed in full chemical gear to simulate the worst case of little or no decontamination at the forward area treatment site. In each situation, the ventilator patient and the patient who needed cardiopulmonary resuscitation (CPR) was the Resusci-Annie-Manikin. In the chemical

situation on the C141B, Resusci-Annie was placed in the casualty wrap rather than in full chemical gear.

TABLE 4. SIMULATED PATIENT TYPES, CONDITIONS, AND TREATMENT

Casualty type	Condition	Treatment
Foreign body, left eye	Stable	IV; Protective bandages
Traumatic amputation, right hand	Stable	IV; Pressure dressing & pain control
Headache, with neuro- deficit	Unconscious	IV; Foley catheter; seizure control
Gunshot wound, abdomen	Shock	IV; Oxygen; NG tube; Foley catheter
Gunshot wound, chest	Shock	IV; Oxygen; NG tube; chest tube; Foley catheter
Dislocation, right femur	Stable	Pain control; post reduction
2nd & 3rd degree burns, face, neck and chest	Unconscious	IVs; Ventilator; NG tube pain control; Foley catheter
Crush injuries, both feet	Stable	IV; Foley catheter; pain control
Fractures, right femur & left ribs	Stable	IV; Traction splint; Pain control

#### Task Evaluation

As mentioned previously the evaluators were split between aircraft simulators and remained in that simulator through both phases of testing. Each task was graded according to a three-point scale: "fully able to perform" (FA), "partially able to perform" (PA), or "unable to perform" (UA).

## Testing

On each of two consecutive days, ten simulated patients were moulaged and placed on NATO-standard litters near the bottom of the aft ramp of each aircraft. Aircrews loaded the patients themselves according to a load plan established at the aircrew briefing held during the moulage session. Takeoff was simulated after loading was completed, and normal inflight patient care activities began during climb-out. Recorded aircraft sounds were played throughout the test period.

The nurse evaluator in each aircraft used 3x5-in. file cards listing changes in patient conditions; and new problems were added to create the need for each procedure to be tested. Those procedures not able to be completed required additional written commentary on the precise limitations observed, as well as appropriate grading.

The CPR task was delayed to near the end of each flight because the task would tire the aircrew excessively; and in a non-combat area, require the aircraft be diverted to the nearest available landing site having competent medical backup.

Following the completion of all nursing tasks, the flight "landed" and testing was secured for the day. Following the second flight, the aircrews were asked to provide written debriefs of their experiences in wearing chemical defense gear.

## RESULTS

### Medical/Nursing Task Performance

All tasks were completed in standard flight gear, although partial completion was due to an obstructed view of the opposite side of the patients caused by the 18-in. vertical litter separation (Table 5). In chemical defense gear there were multiple problems with task completion, as detailed in Table 6. Problems were reported more frequently in the C-130 aircraft simulator in both scenarios.

**TABLE 5. MEDICAL/NURSING TASK PERFORMANCE DIFFICULTIES  
IN CONVENTIONAL SCENARIO**

<b>Task</b>	<b>Rating</b>	<b>Explanation</b>
3. Reinforce dressings	PA	Obstructed view on far side of body
4. Reinforce dressings	PA	Obstructed view of wound

Note: PA = Partially able to complete some components of task  
 UA = Unable to complete the components of task

**TABLE 6. MEDICAL/NURSING TASK PERFORMANCE DIFFICULTIES  
IN CHEMICAL DEFENSE SCENARIO**

<b>Task</b>	<b>Rating</b>	<b>Explanation</b>
1. Obtain vital signs	PA	Gloves restricted sense of touch and prevented taking pulse and BP readings; ventilations probably best-observable vital sign.
2. Tracheal suction	UA	Requires two persons to perform in CW situation
3. Reinforce dressings	PA	Difficulty with tape; obstructed view of wound area due to restricted space

**TABLE 6. (Continued)**

<b>Task</b>	<b>Rating</b>	<b>Explanation</b>
4. Reinforce dressings	PA	Difficulty with tape; obstructed view of wound area due to restricted space
8. Oropharyngeal airway	UA	Difficulty opening components and in communicating with assistant (2-person task)
14. Provide meals/snacks	UA	The CPE on patients prevents performance of this task

**Note:** PA = Partially able to complete some components of task  
UA = Unable to complete the components of task

### **DISCUSSION**

The outstanding record of patient care established in daily conventional practice by these crews is apparent. However, the standard of care established in conventional conditions is not necessarily applicable in contaminated aircraft. In the literature, the coverage of the effectiveness of AECMs in a chemical environment has been sketchy. Limited exposure to persistent agents is always a possibility when there is a requirement for rapid airlift of wounded from a zone of conflict. This study raises a number of questions concerned with current training, doctrine, and equipment regarding aeromedical evacuation in a CW environment.

In the NATO-standard aircraft configuration, there are problems with patient access and visibility even with standard flight gear. The 18-in. vertical litter separation standard has been in effect for some time and can even be traced back to early aeromedical aircraft. Anecdotal accounts of creative litter spacing performed by the aircrew, done by guess and experience on the spur of the moment, appear to have validity. Further investigation of optimal patient care litter spacing may be indicated. A U.S.

Army preliminary study indicated that 20 inches may be more appropriate spacing to perform medical tasks in aeromedical evacuation (medevac) aircraft.

When chemical defense gear is added to the scenario, many necessary tasks cannot be performed effectively. Alterations to standard procedures and/or equipment, or expedient substitutes for these tasks must be developed. Clearly, the present aircrew CPE was not designed to be used in medevac aircraft. Devices to aid in patient assessment are required. Penholders attached to uniform legs and a large clock mounted on a bulkhead should not be difficult to implement. Aside from visibility problems, the current CPE masks will not allow adequate hydration or oral communication; this problem must be addressed. Perhaps the suggestion that a subset of universal sign language be taught to aeromedical personnel should be seriously considered. The current solution of making private line headsets available to cabin crew does not address the chemical contingency. Of course, there must be serious efforts to integrate this sign training into aeromedical missions on a regular basis.

Heat effects and work/rest issues are significant issues. The crews tested were just able to improvise a schedule and share the workload for these 10 patients for two hours. Serving a full planeload of patients in CPE would have been impossible; a longer flight would have exhausted the crews, even with ten patients. A clean (uncontaminated) area away from the patients where resting crews could more safely break the seals on their masks might be feasible. A plan for aircrew augmentation, in the context of formal work/rest and manning studies, should be considered.

The current CPE is not designed for wear by injured individuals. There is no way that any invasive nursing care measure can be performed without violating the integrity of the chemical gear. The 18-in. vertical litter spacing, coupled with the reduced visibility afforded by chemical protective gear, makes it extremely difficult to perform even noninvasive nursing care tasks such as casualty assessments. The casualty wrap as used on Resusci-Annie did not permit any evaluation of the manikin.

### Limitations of the Study

There are some obvious limitations to the study. The AECMs were all qualified and experienced crew members; other AECMs may have less or more experience in aeromedical evacuation. Therefore, the study subjects

may not be typical of the population of aeromedical evacuation crews. Despite their random selection to each aircraft, the crews were a convenience sample of flight nurse/aeromedical evacuation technicians from the USAFSAM and the 34th AEF.

The second limitation of the study was the patient population. The USAF and USMC simulated patients were all healthy personnel from the USAF Security Police School at Lackland AFB, Texas. In a real combat situation the patients would be severely compromised. While this is a limitation of the study, the observations suggest that the reality of an actual combat medevac situation would be a worst case example in trying to manage nursing care. The number of patients was also a limitation in this study. Because the number of patients was so small, it was probably easier to manage the nursing care given the extremes of the situation. Once again, the reality would probably be worse because the number of patients would be greater.

The final limitations of the study relate to the simulator/trainers. The trainers cannot simulate all of the stresses of flight; specifically, barometric changes, vibration, decreased partial pressure of oxygen, G forces, and decreased humidity. Once again, if these conditions of flight could have been simulated, they would have had even more negative influence on the findings of this study.

## RECOMMENDATIONS

The limitations of this study narrowed its scope; nevertheless, several recommendations can be made based on the findings. First, the study should be repeated using other AECMs; the second study should be compared with this study. Second, the study should be replicated using operational aircraft to incorporate all the stresses of flight into the testing situation. Third, the replication studies should use longer flights with more simulated patients. Each of these replication studies could incorporate some of the "quick fix" recommendations for some of the problems encountered; e.g., hanging a large clock on the bulkhead for observation by the crews. Fourth, the study should be repeated using the new USAF flight CPE.

## CONCLUSION

The effectiveness of AECMs in CPE was investigated using moulaged patients in aircraft mockups. In observing a variety of wartime medical/nursing tasks performed by AECMs, senior evaluators identified problems with patient access and assessment using NATO-standardized litter spacing during both normal and contaminated operations. Further studies are necessary to determine optimal vertical spacing for the full range of patient care tasks. Wearing CPE caused serious interference with patient care, communications, and individual performance. Aircrew exhaustion, even in moderate environments and flight times, suggests the need for further investigation of work/rest cycles and of AECM manning doctrine in chemically contaminated aeromedical operations.

### Performance Ratings

Figures 1-23 analyze the assigned ratings of complete, partial or incomplete by the evaluators after direct observation of AECM performance of the specific medical/nursing tasks during the simulated missions. Comparison is made between the AECM performance of tasks during the simulated conventional missions with their performance during the chemical scenarios. Compromise of individual protective equipment is indicated where it occurred.

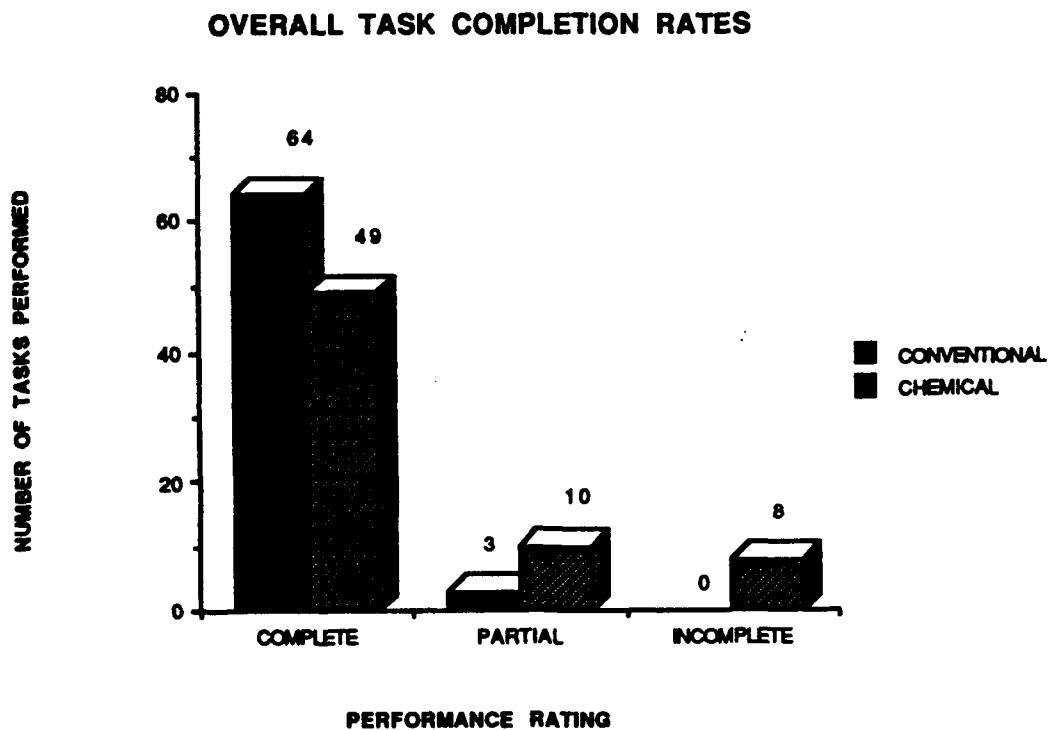


Figure 1. Combined chemical and conventional task performance ratings.

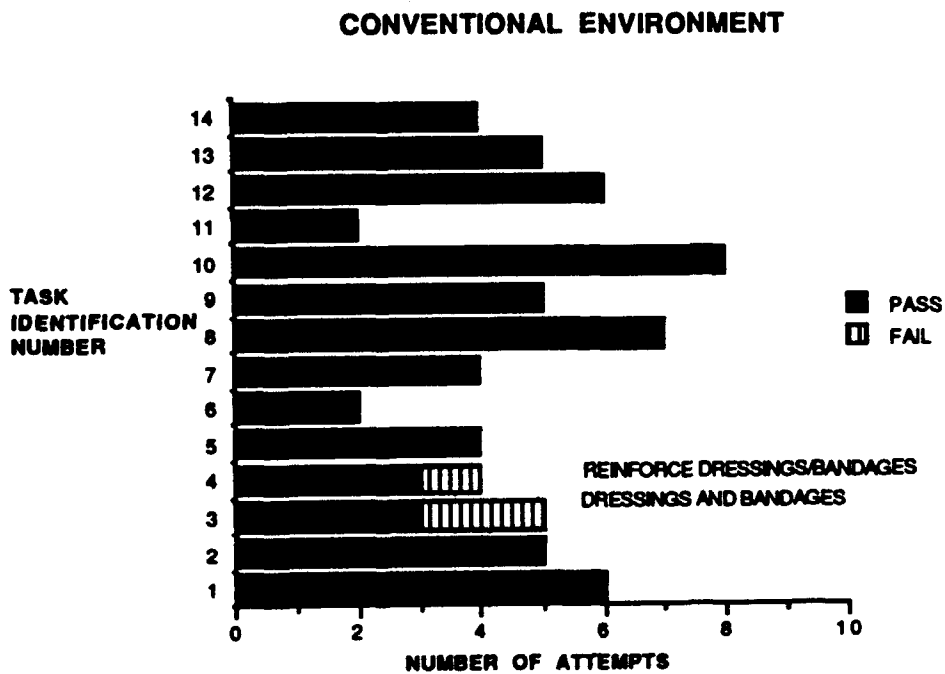


Figure 2. Individual task completion ratings, conventional scenario.

### CHEMICAL ENVIRONMENT (Protective Barriers Maintained)

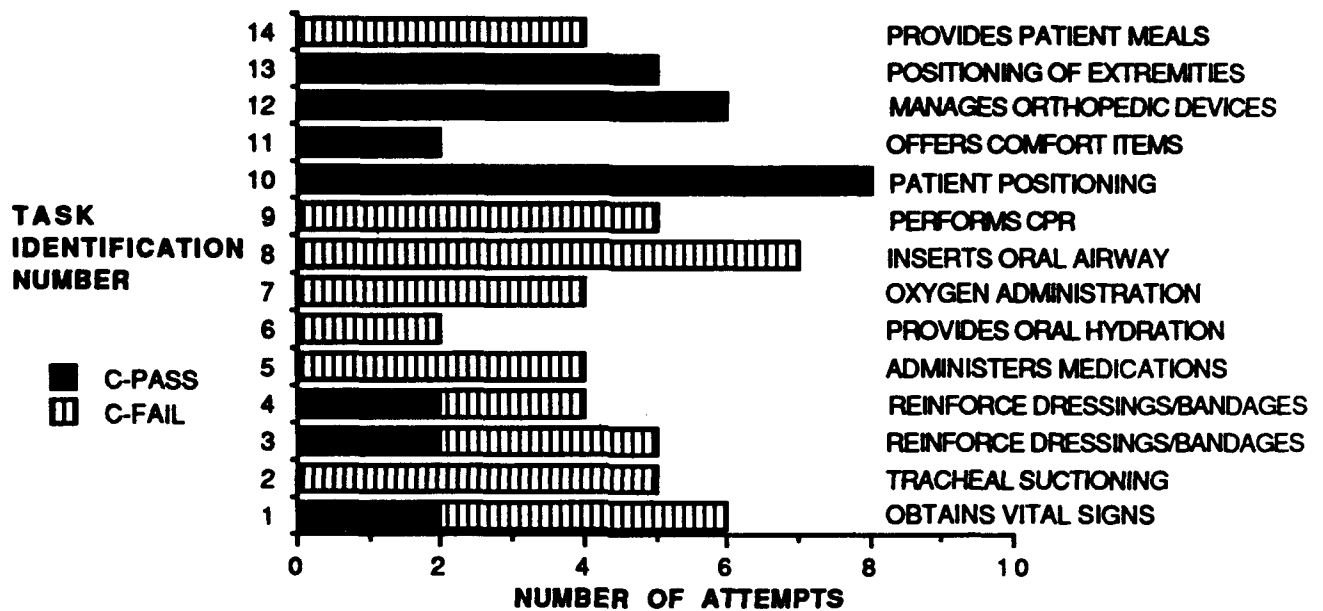


Figure 3. Individual task completion ratings, chemical scenario.

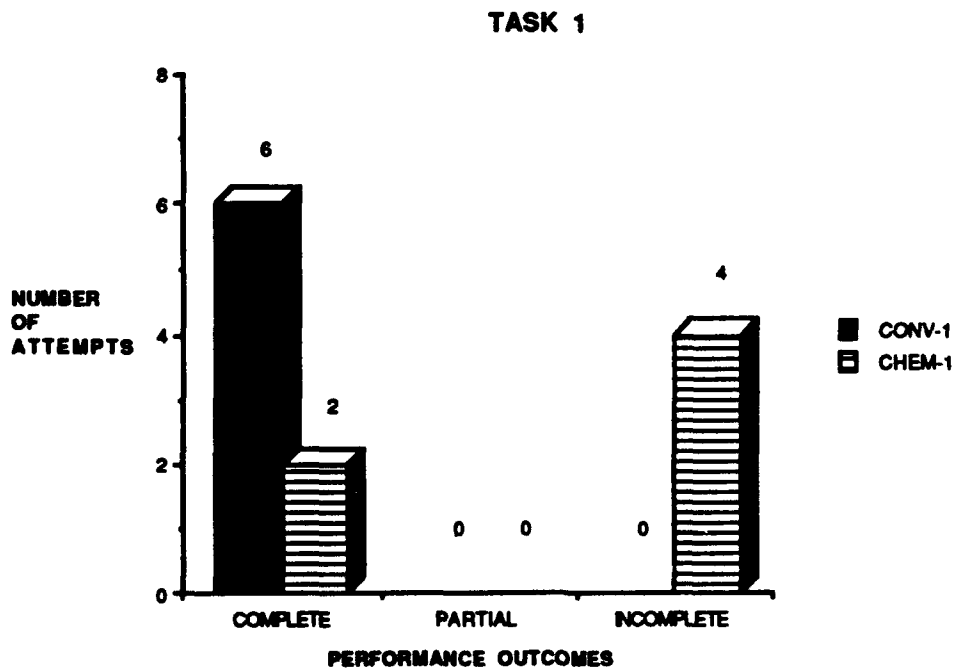


Figure 4. Vital signs.

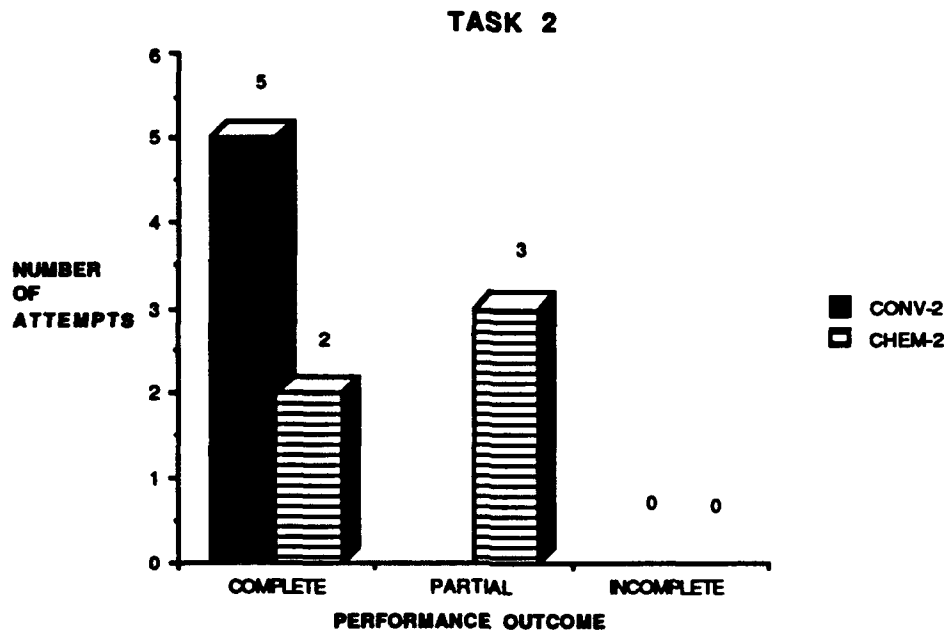


Figure 5. Tracheal suction (protective barrier broken).

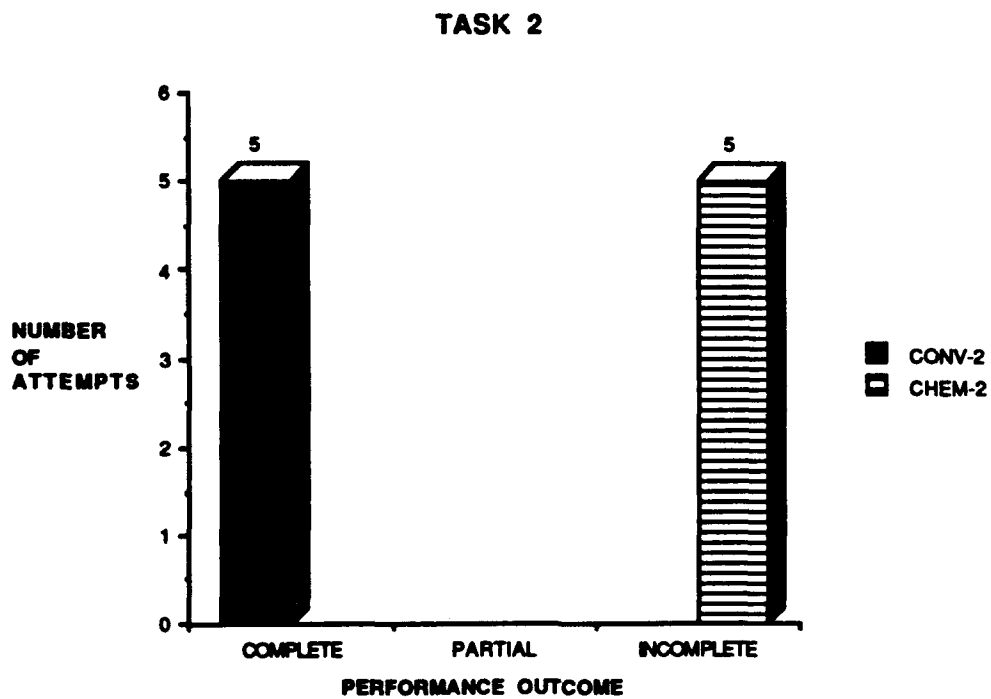


Figure 6. Tracheal suction (protective barrier maintained).

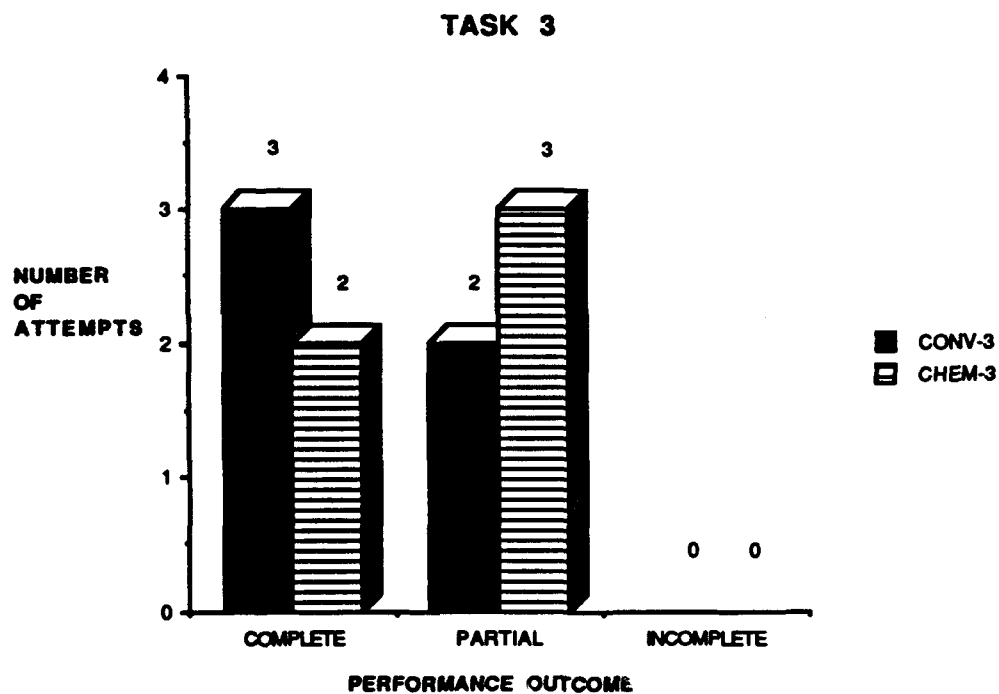


Figure 7. Dressings and bandages (extremities).

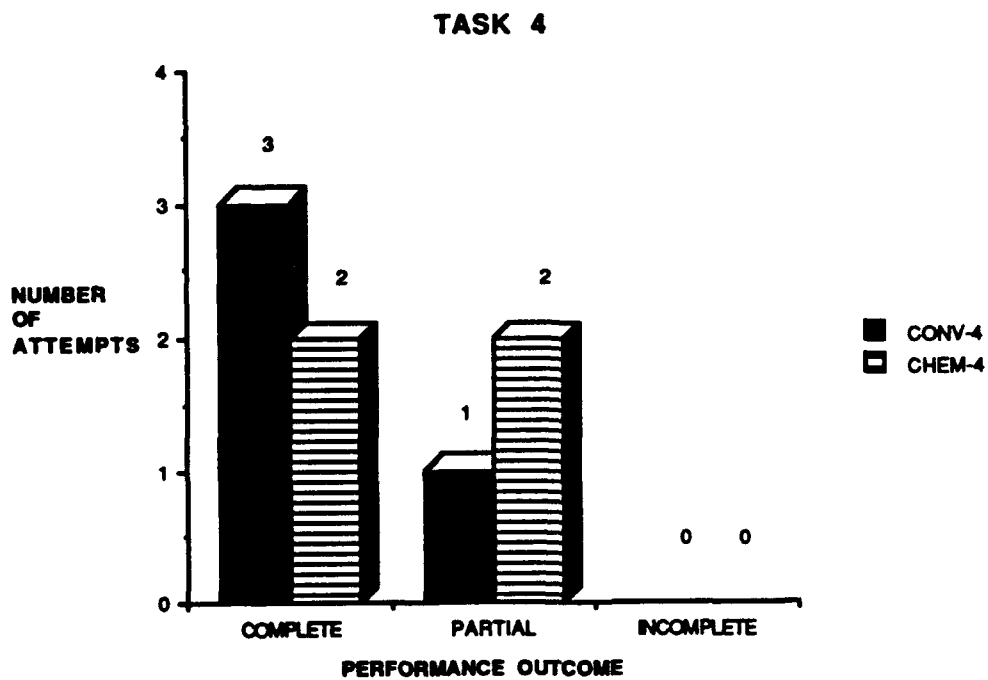


Figure 8. Dressings and bandages (abdomen/back).

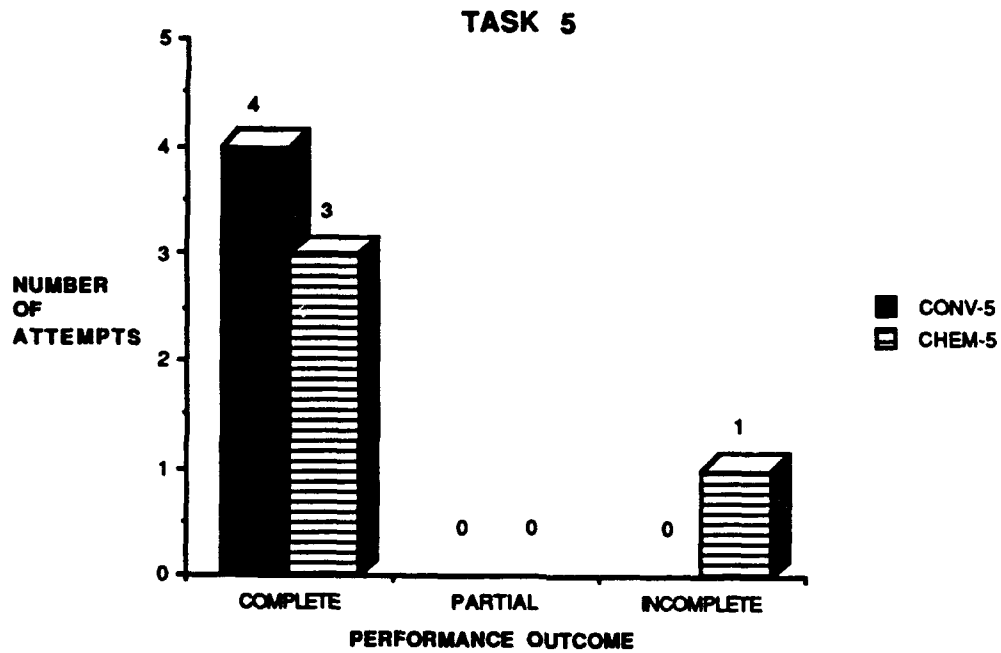


Figure 9. Medication administration (protective barrier broken).

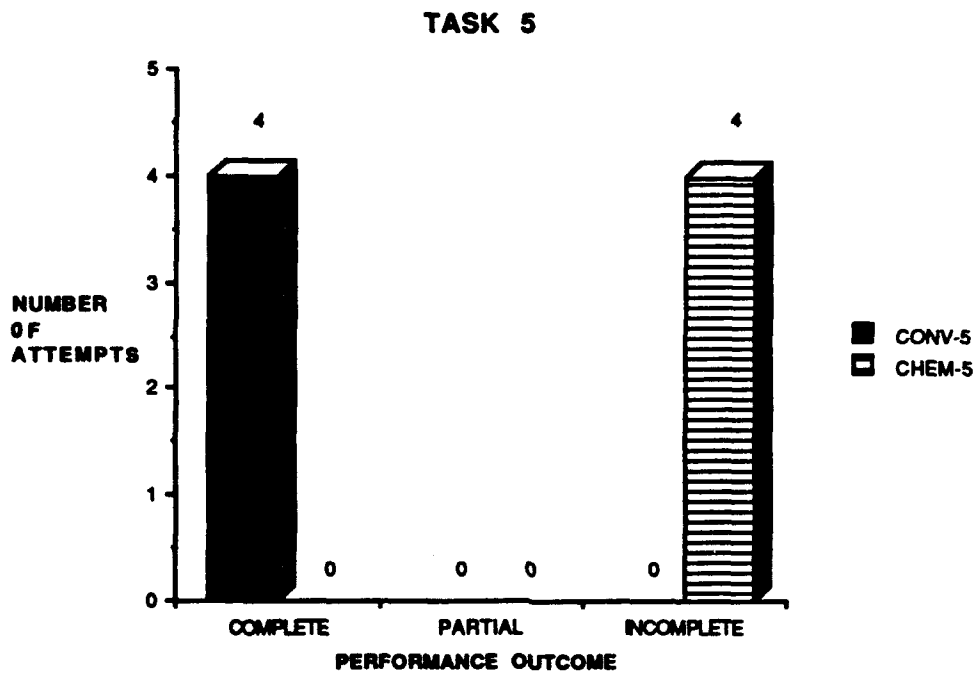


Figure 10. Medication administration (protective barrier maintained).

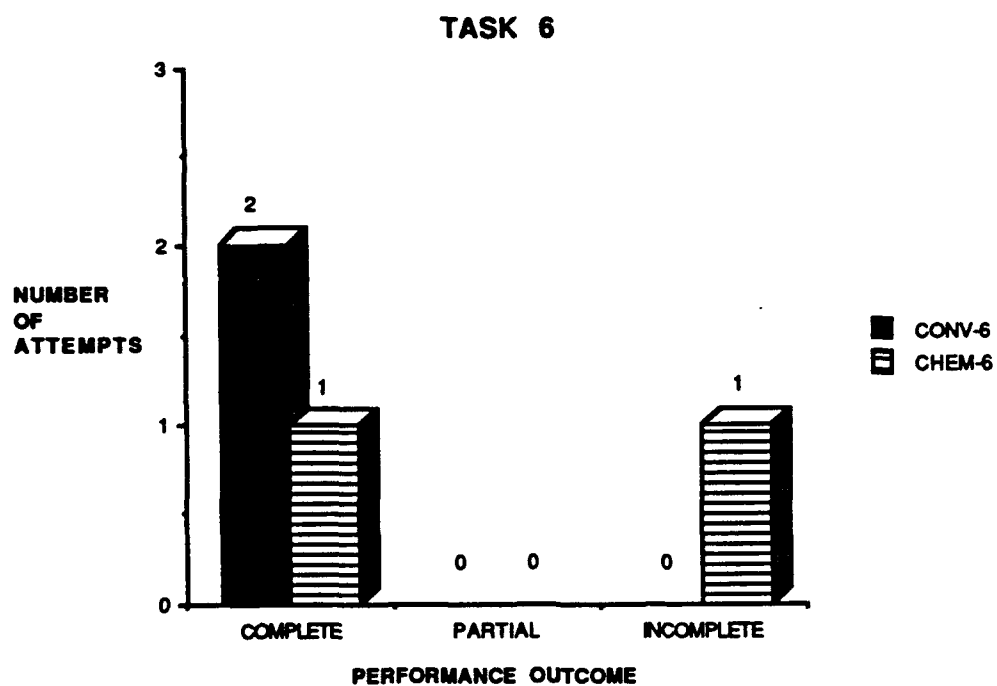


Figure 11. Fluid administration (protective barrier broken).

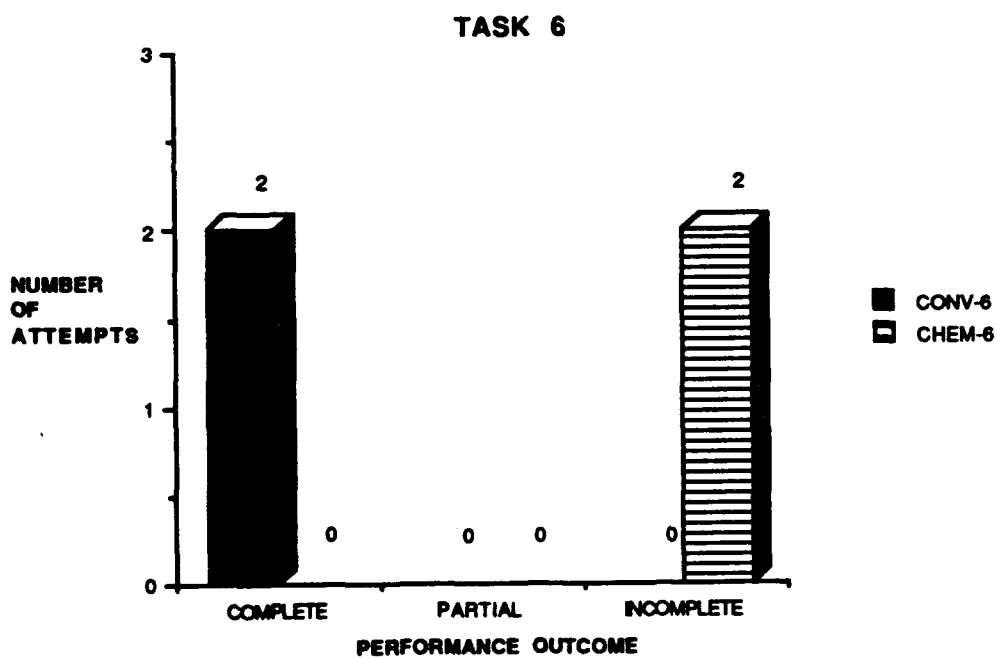


Figure 12. Fluid administration (protective barrier maintained).

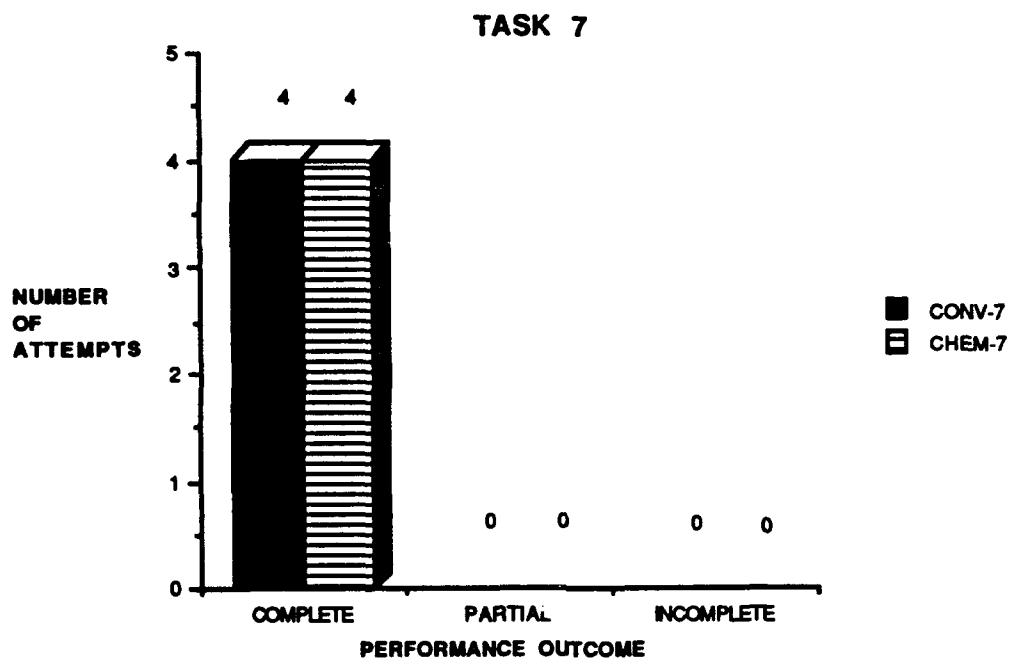


Figure 13. Oxygen administration (protective barrier broken).

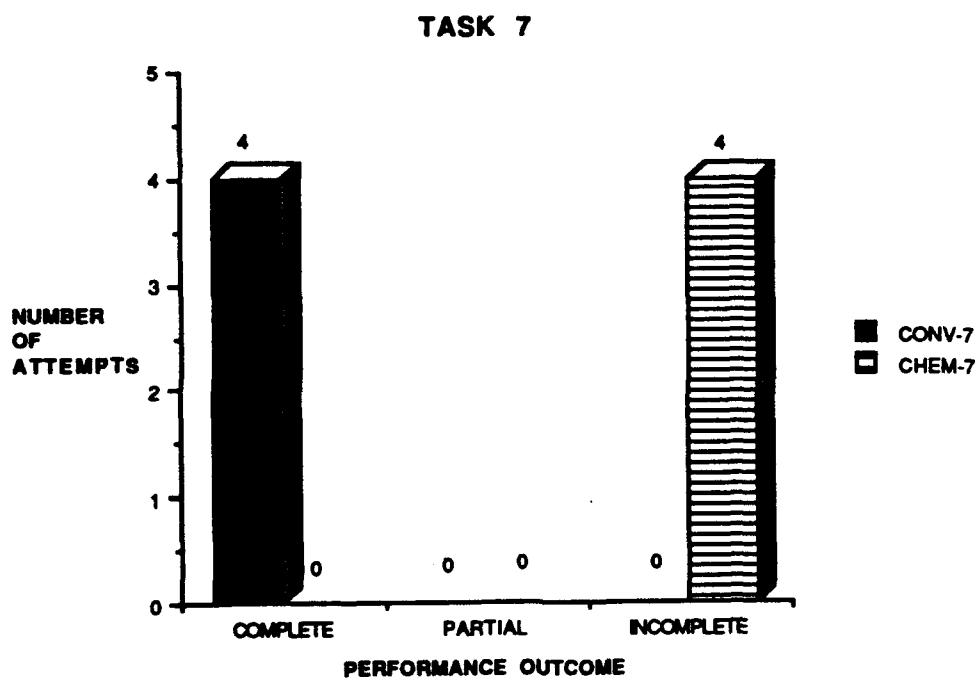


Figure 14. Oxygen administration (protective barrier maintained).

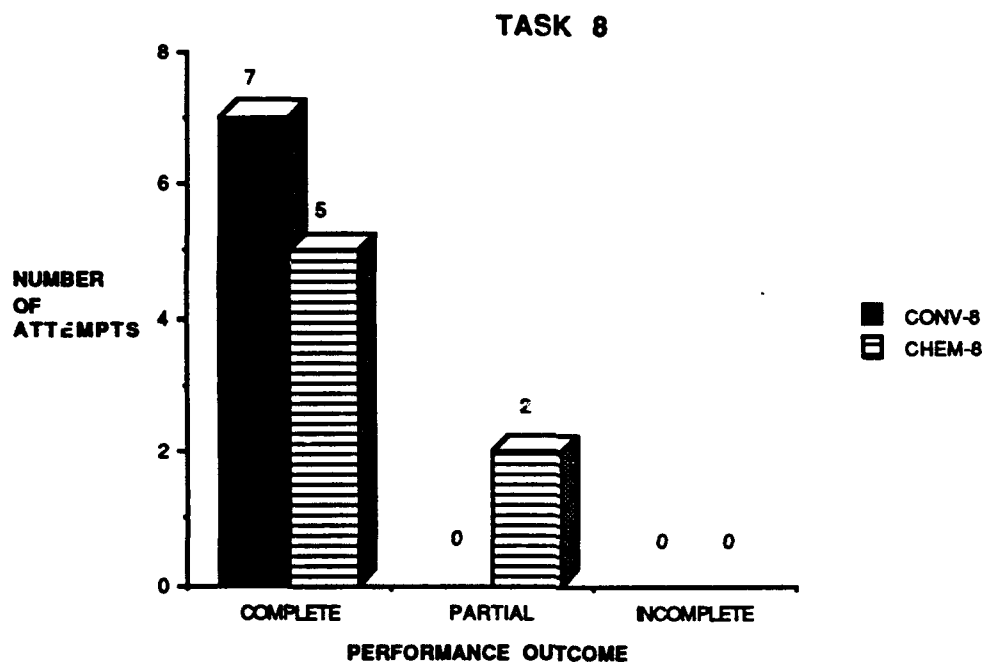


Figure 15. Oral airway (protective barrier broken).

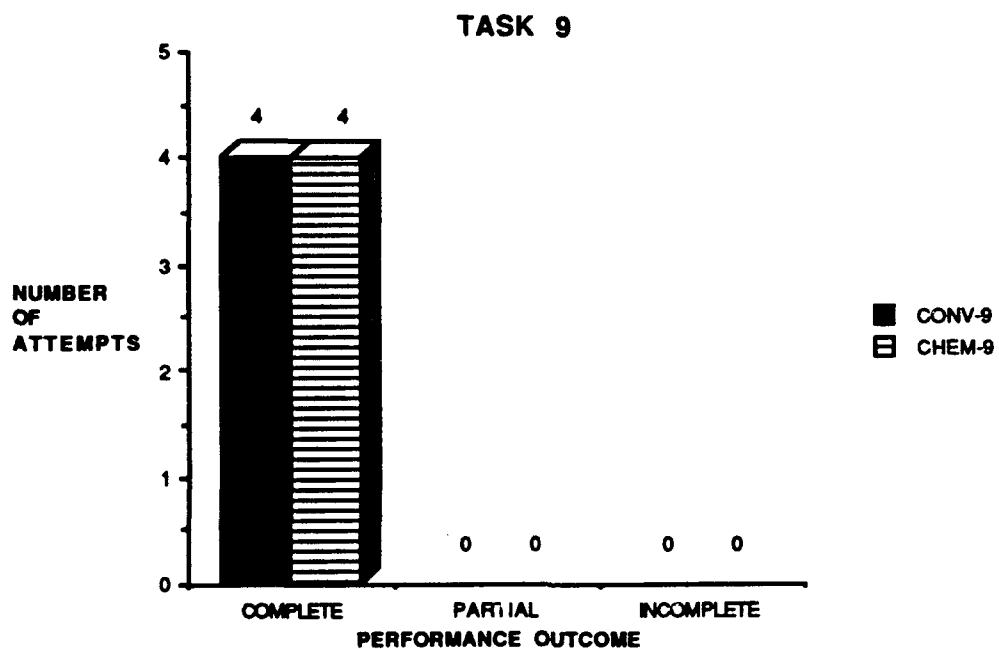


Figure 16. Cardiopulmonary resuscitation (protective barrier broken).

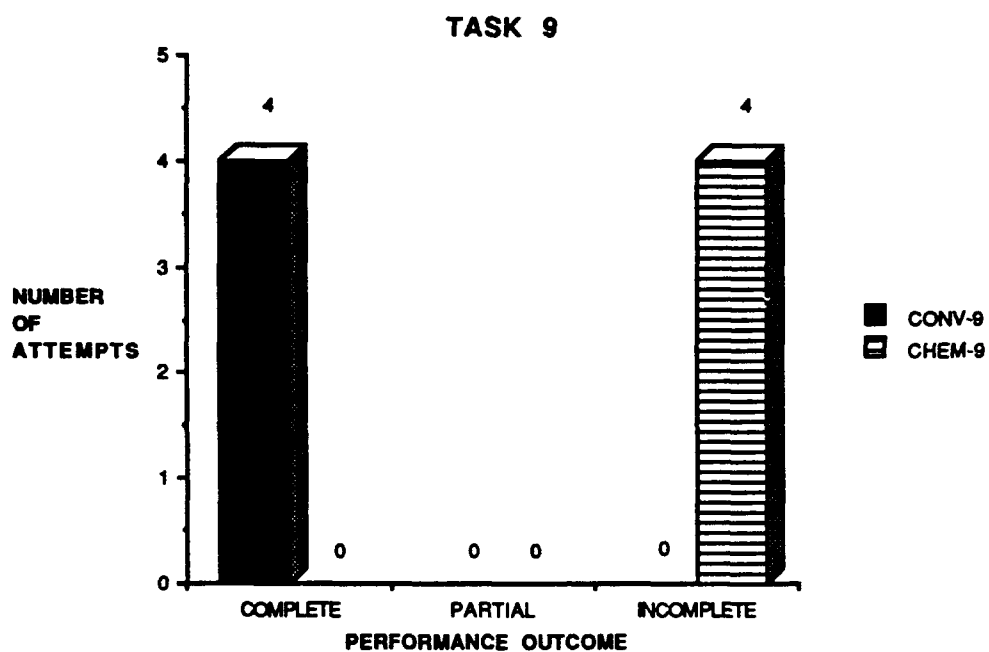


Figure 17. Cardiopulmonary resuscitation (protective barrier maintained).

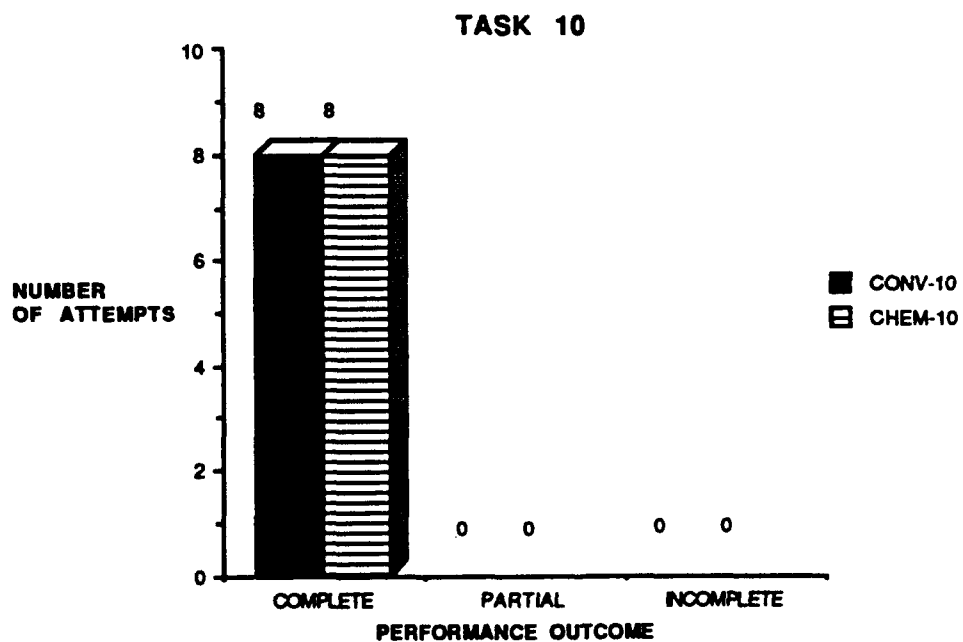


Figure 18. Patient positioning.

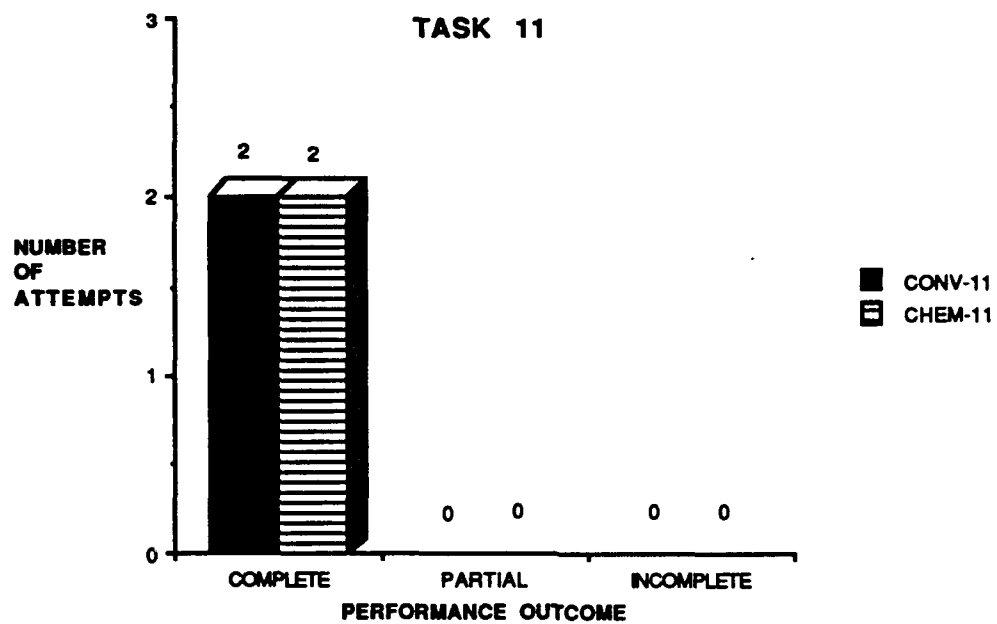


Figure 19. Patient comfort.

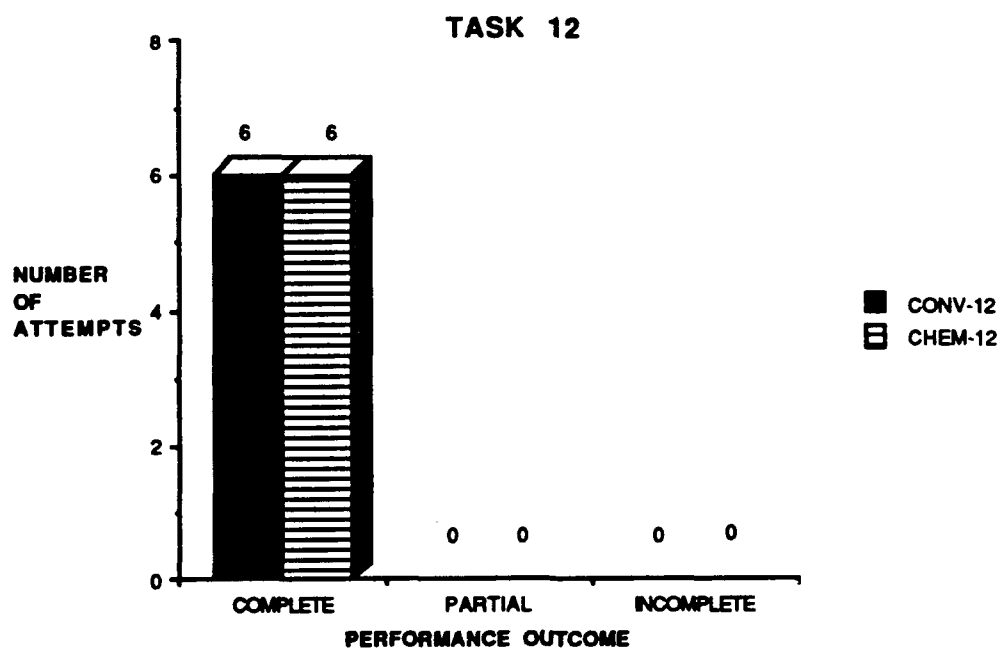


Figure 20. Management of orthopedic devices.

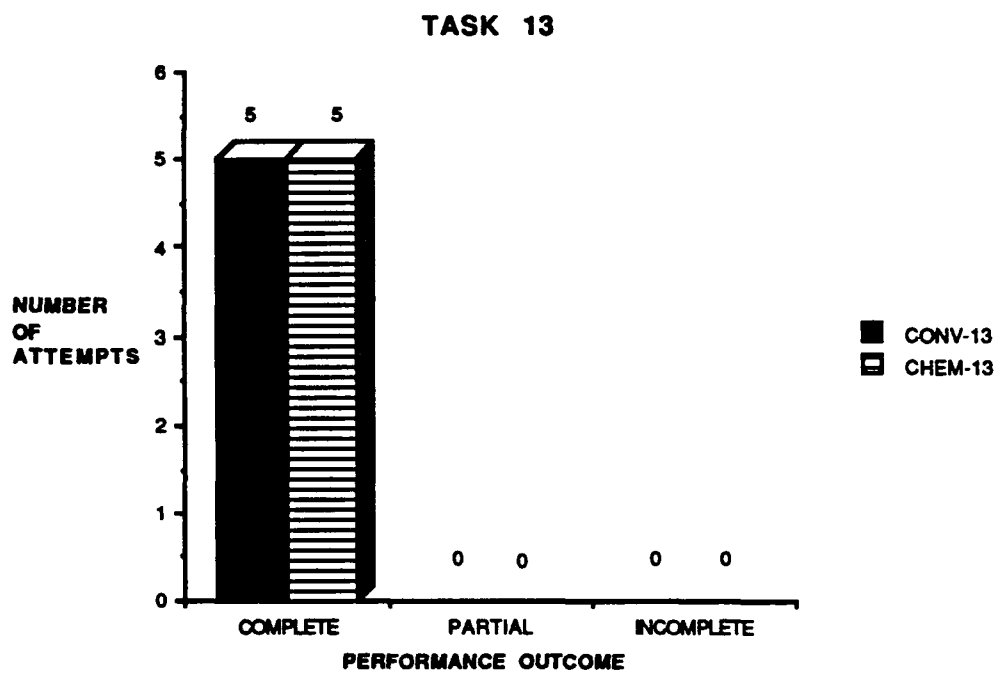


Figure 21. Positioning of extremities.

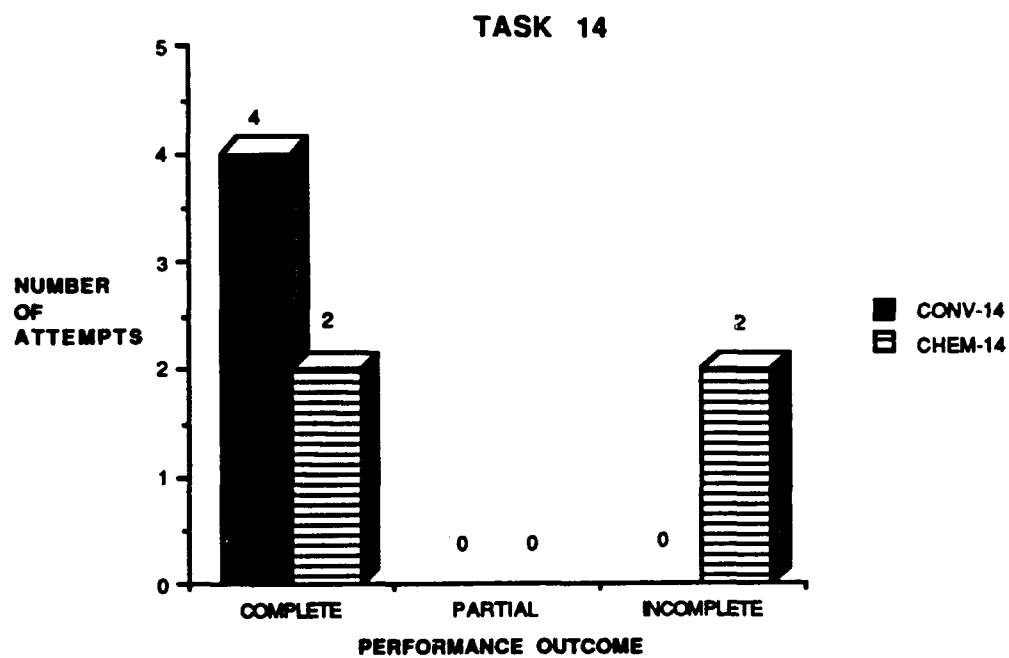


Figure 22. Patient meals (protective barrier broken).

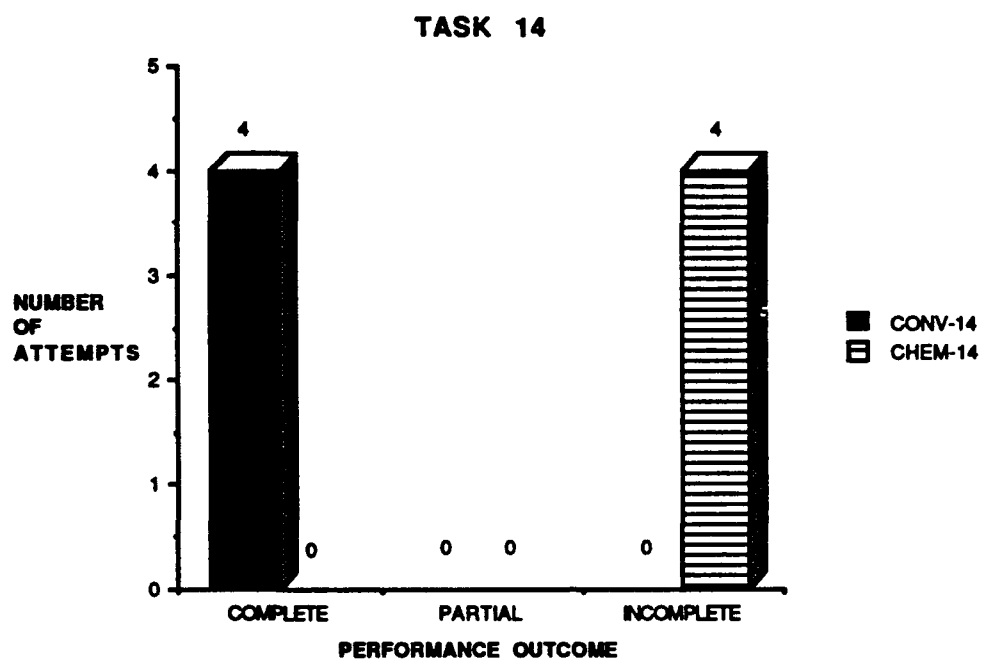


Figure 23. Patient meals (protective barrier maintained).

## **APPENDIX**

### **Participant Debriefing**

Comments from the aircrews obtained from the written debriefing paralleled and amplified the difficulties observed by the evaluators. The debriefing comments are reproduced below. The comments of the evaluators are identified separately and all comments have been extracted and grouped by subject matter.

#### **Chemical Defense Gear**

"Most tasks are more difficult to perform. Some require more time; some require two persons to accomplish. Some tasks cannot be accomplished without compromising the integrity of the [patient's] gear."

"My problem is feeling claustrophobic in the gear."

"The gear disabled me to accomplish many of the needed tasks as an aeromedical technician."

#### **Evaluator Comments:**

C-130 evaluator: "The value of working in chemical gear can be understated. The tolerance level of personnel was vastly shortened, but it was interesting to note how they initiated a work/rest cycle in order to adjust to the gear."

C-141 evaluator: "The ensemble is not acceptable for AECMs. It decreases peripheral vision which is critical to nursing task accomplishment."

#### **Work/Rest Cycles**

"Most tasks must be performed at a slower pace as fatigue sets in quickly. We probably need two full crews to accomplish tasks because one crew would become fatigued too quickly."

"I tire much quicker with chemical gear on."

"I had to work at a snail's pace and keep calm, no matter what the situation."

"Work had to be paced so that fatigue would not develop."

"Tasks such as loading and securing items had to be slowed down to ensure that the crew was not overworked. More breaks/rest periods needed to be taken."

"Time would be a major concern [in the real situation]. Two hours would probably be the maximum time I could work in this gear without an extended break."

"Based on minor difficulties with onload of patients [on the first day], I chose to enplane patients rather than direct flow as the MCD. This left me more fatigued. I took periodic breaks trying to pace myself, even disconnecting my mask from the filter for better airflow, I still became fatigued. I felt cool as though air conditioning had come on, but on checking with crewmembers, it was still warm. Realizing I was overheating, I had to remove my mask and hood and loosen my gear to avoid injury."

"A lot of consideration needs to be given to pacing yourself. It is hard to do that much for even that many people [10 patients]. If possible, some of the crew should sit and rest while others work, then switch off."

#### Evaluator Comments:

C-141 evaluator: "Fatigue is a tremendous factor along with endurance. Crews will need to be augmented and planned for. . . Crew members adopted a work/rest pattern to provide care to 10 patients for only 2 hours, and fatigue was significant."

#### Litter Spacing

"Given the litter spacing used, it was almost impossible to try to get the mask off a patient."

"The helmet was great to have due to the limited working head room and decreased visibility. I kept hitting my head."

### **Evaluator Comments:**

C-130 evaluator: "The 18-inch spacing did have an effect on movement of patients in positioning for comfort and in visualizing wounds for inspection. AECMs more than once hit their heads on upper litters or on litter stirrups when giving care."

### **Telling Time**

"A large clock should be mounted in the aircraft. In chemical gear, you are unable to see watches to measure time intervals."

"I could not get to my watch because of the gear, so I was at a loss for time to document such things as medications, treatments, etc."

"I was unable to tell time while wearing the gear."

### **Evaluator Comments:**

C-141 evaluator: "Some type of visible timepiece should be incorporated into medical aircrew supplies because medical treatments and medications are time dependent and watches cannot be seen under chemical gear."

### **Communications**

"It was difficult to communicate with both crewmembers and patients."

"Would it be feasible for aircrews to learn basic sign language? You cannot talk at all, especially in chemical gear, and a few basic signs would help immensely."

"Communication was impaired with the gear on."

"Communication was difficult with the mask in place."

"Communications were inhibited, I had to yell which contributed to my fatigue."

"Pay attention to communications because it is difficult to hear and talk. Things said are often misinterpreted."

### Vision

"My field of vision was greatly reduced. [This is] a safety factor when moving about the aircraft. Sweat poured into my face mask and blurred my vision."

"Peripheral vision was impaired by the helmet and mask."

"Due to decreased visibility, I kept getting tied up in the oxygen and electrical lines."

"Lack of visibility of patients' faces hindered AECM's abilities to determine patients' distress levels."

"Vision was impaired by the helmet, mask and hood."

"Peripheral vision was restricted and the aircraft light glared."

"The [issue] mask was scratched and caused lights to "star" which disabled my vision."

### Helmet

"The helmets were a lifesaver. I would have torn my head open a couple of times on litter stirrups as my peripheral vision was impaired."

"Pain developed on my scalp and mandible from the tight strap. It becomes almost unbearable."

"The helmet was great to have due to the limited working head room and decreased visibility. The helmet, mask and filter were very heavy. I was stressed on the head and neck in a very short period of time."

"Keeping the aircrew mask on for the [2 hours] caused major discomfort. It was hard to breathe in and straps were irritating to the head."

"The mask needs a water straw."

"Crew masks as well as patient masks did not have drinking tubes. It would be too difficult to explain to patients how to drink safely by breaking the mask seal in the aircraft environment."

**Evaluator Comments:**

C-141 evaluator: "Peripheral vision is greatly decreased."

**Heat Stress**

"It is very hot in the aircrew ensemble. Sweat dripped on the inside of my mask and blurred my vision."

"The heat factor made my own pulse more pronounced [in my fingertips]."

"Comfort in the gear is a real problem. The outside temperature was only 68-70° C. At this temperature I did not feel too overheated to accomplish my duties, but I had heat problems in the suit."

"I could easily overheat in the suit. The perspiration which rolls down your face becomes very irritating."

**Other Comments**

"The issued flight gear does not work with chemical gear added. It needs to be one or two sizes larger to accommodate the chemical gear. A pencil slot on the outer suit needs to be on the leg for easier access."

"Manual dexterity is greatly reduced. I was unable to easily open packages of supplies."

"I tended to concentrate on very minor things like an itchy nose, which normally I do not think about. Palpating pulses was difficult; it was hard to distinguish my own pulse from the patient's pulse."

"Accomplishing tasks that required gross motor skills were not a problem. Those requiring fine motor skills took longer. Assessment of patients wearing chemical gear is difficult."

"Crewmembers were unable to hydrate themselves because of the gear. Working with gloves on made taking vital signs and reinforcing dressings with tape impossible. "

"I was unable to take vital signs. Neurovascular status was very difficult to check. Canteens with drinking spouts were needed to hydrate patients and masks having drinking adapters are needed for the aircrew masks."

"The gloves were bulky, and I was unable to perform tasks such as vital signs. Securing bandages was difficult due to tape sticking."

"My hearing [acuity] was greatly reduced. It took longer to accomplish routine tasks."

"Chemical gear prevented me from being able to accomplish many of the needed tasks as an aeromedical technician. A penholder on the chemical gear needs to be on the leg due to problems reaching and seeing the present location."

"Intramuscular injection would violate the integrity of the chemical gear. Even when judged necessary, it requires tough scissors and real dexterity to cut an opening in the suit. Restarting an intravenous line is nearly impossible unless you have a large vessel that is easily identified by sight. Palpation is limited. It is very hard to tell if a patient is breathing or not when he is wearing the chemical gear."

#### **Evaluator Comments:**

C-141 evaluator: "Crewmembers cannot hydrate themselves effectively in protection masks and they must be able to do so. . . There is no method to effectively deliver therapeutic masks. . .It was questionable whether vital signs were obtained in chemical gear, and this was on healthy patients."

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